Metallindustrins omställning

Innovativa lösningar för en fossilfri framtid

Ida Heintz & Nuria Fuertes

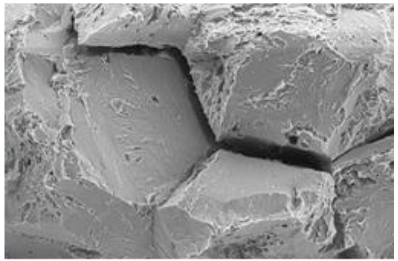
”Swerim bedriver industrinära forskning och utveckling kring metaller och deras väg från råmaterial till färdig produkt.”

”Vår vision
är en fossilfri
och cirkulär
industri.”

Kort om Swerim

- Oberoende industriforskningsinstitut
- Cirka 190 medarbetare
- Två huvudorter: Luleå och Stockholm
- Omkring 250 miljoner kronor i omsättning
- Unika test- och demonstrationsanläggningar
- Kunder över hela världen
- Ägs av industrin (80%) och RISE (20%)

Lång tradition – den äldsta delen grundades ”Metallografiska institutet” (1921) samt MEFOS (1963)



SWERIM

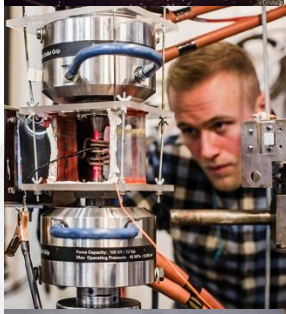
National Hydrogen Research Centre for Metallic Materials

Nuria Fuertes, Ida Heintz, Stefan Marth, Pontus Rydgren

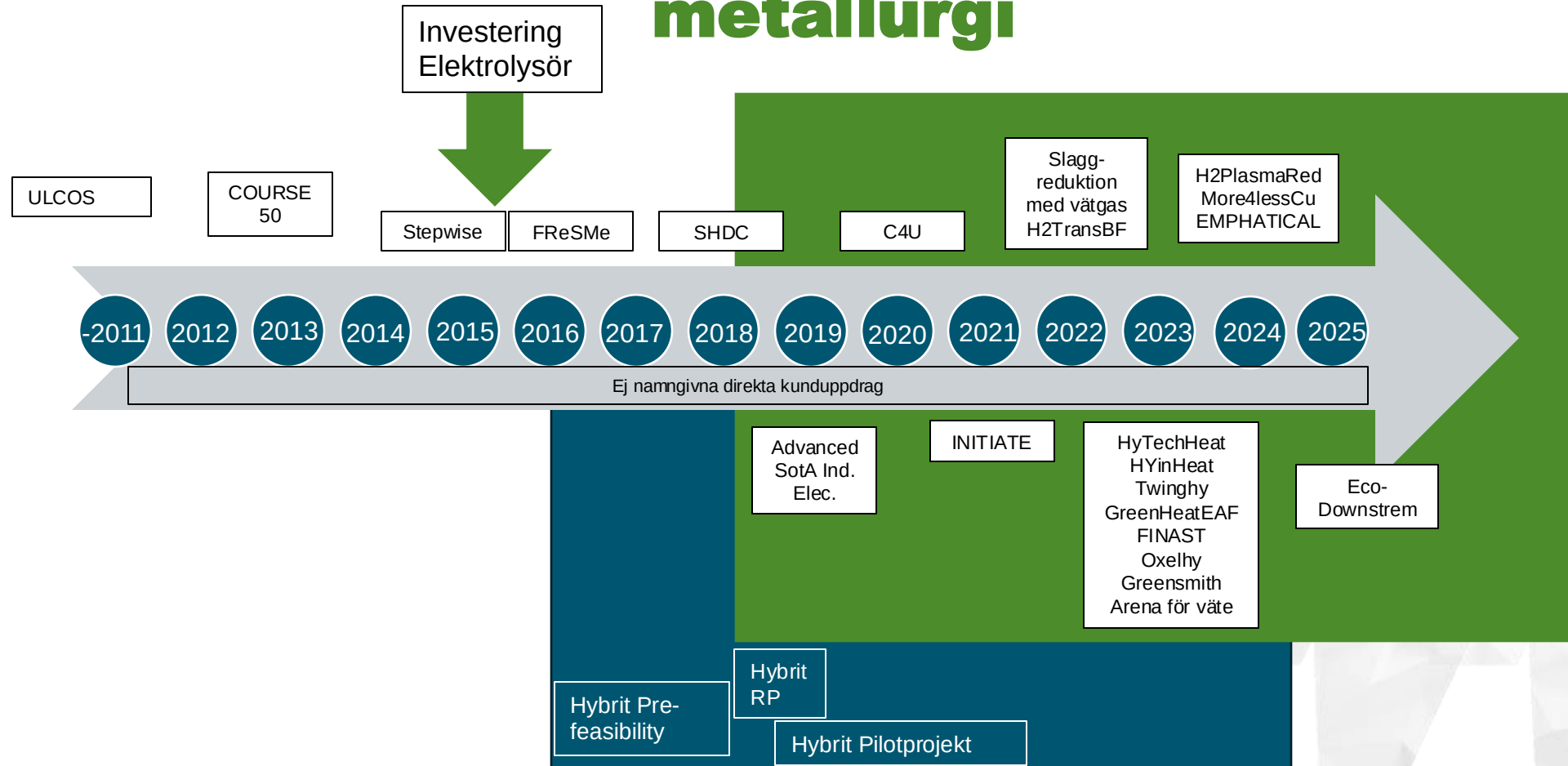
The role of Swerim for a Fossil free Sweden 2045

Swerim and Hydrogen Research

- Expertise on hydrogen production, processing and use in metallurgical applications as well as material testing and hydrogen-metal interaction
- Alloy design and testing for improved hydrogen embrittlement resistance
  - 20 years with hydrogen embrittlement research
- Test-bed for electrolysis and hydrogen processing
- Metallurgical and heating process development
- Strong network and collaboration with main H_2 related Swedish industry
- Currently, the only research institute in Sweden performing hydrogen gas mechanical testing
- Large investments approved and planned for 2023-2026

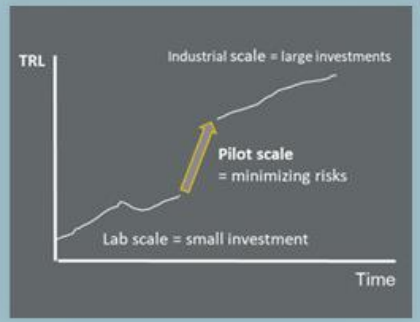


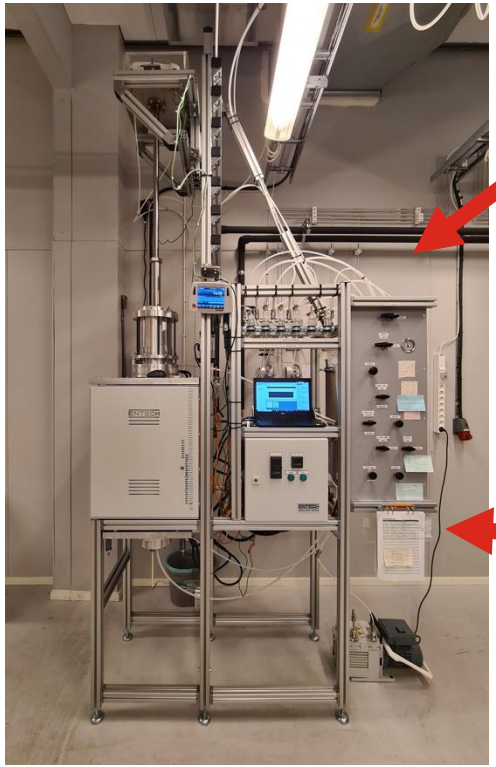
15 år med vätgas-metallurgi

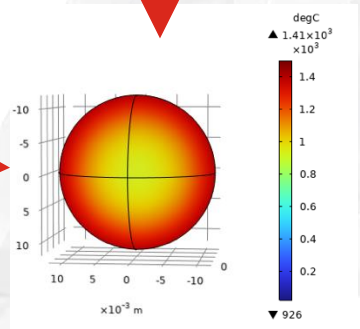


Varför pilot- och demo?

- Studera kontrollerande mekanismer - labbskala
  - Få variabler
  - Välkända förhållanden
  - Isolera fenomen
- Simulera process – pilotskala
  - Fler variabler
  - Svårt att kontrollera alla förhållanden







Europe's largest facility for gas processing: evaluation, upgrading and re-use of gases


BFG pipeline

Organisation	Gas Supply	Flow to Separation (Nm^3/hr)	Flow to gas processing (Nm^3/hr)	Status
Swerim	BFG	800 for high P 2500 for low P	50 CO_2 (240 in 2023) 40 H_2 (100 in 2023)	
	BOF (2023)	400 for BOF	CO_2 + H_2 (2023)	
	Electrolyser		100 H_2 (Electrol.)	Investment planned for 2026
	LPG	as required	as required	

Gas Processing Technology Platform

TNO innovation for life


TRL 2
0.002 kg


TRL 3
0.05 kg


TRL 4
2 kg


TRL 5
100 kg

Development without Swerim

More (2-4) spin-off development projects expected from STEPWISE facilities

More spin-off (2-3) development projects expected from INITITATE facilities

More spin-off (1-2) projects expected from industrial trials

TRL 6

STEP WISE

3000 kg

FReSMe

C4U

Development with Swerim

TRL 7

INITIATE

10000 kg

BFG pipeline

Heat Management of Technology

H_2 electrolyser

Production of Methanol from BFG

Utilisation of H_2 in reheating processes

Post-combustion CO_2 capture (paving way for EAF)

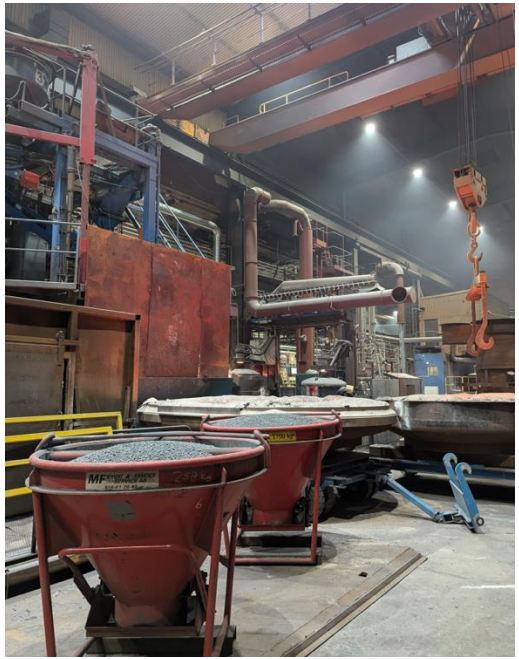
BOF pipeline

Bankability proof for ammonia and Urea production

Industrialisation

EAF-based green steelmaking (10-ton-scale EAF at Swerim)

SWERIM



Materials handling

DRI/HBI melting in the EAF

Tapping

Ny Demonstrationshall

- Stort intresse för uppskalnings av tekniker för industriell omställning
- Identifierat behov av ytterligare demonstrationsytor
- Beviljats stöd från ERUF
- Design/förprojektering pågår – ta chansen att riskminimera hos oss!
- Kontakt ida.Heintz@swerim.se

CO-FINANCED BY
Swedish Agency for Economic and Regional Growth
Co-funded by the European Union

Lärdomar

- Genomfört flera kampanjer med vätgasinjektion i metallurgiska processer
  - Säkerhetsfrågor
  - Processfrågor
  - Egen produktion och intern infrastruktur
- Buffertkapacitet viktigt vid användning
  - Vätgasproduktion kan variera trots reglerade system
  - Produktion av produkten får inte äventyras
- Efterfrågan på högre vätgasflöden
- Ställs högre krav på analys och mätteknik

Importance of Hydrogen in a Fossil-Free Society

SWERIM

Photo: Kanthal

KANTHAL

Energimyndighet rapport, 2023

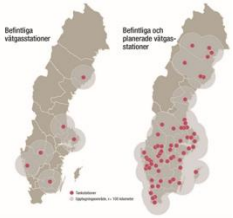


Photo: Volvo

SCANIA VOLVO

Photo: Stegra

Photo: SSAB

LKAB

August, LKAB

ALFA LAVAL

Photo: Alfa Laval

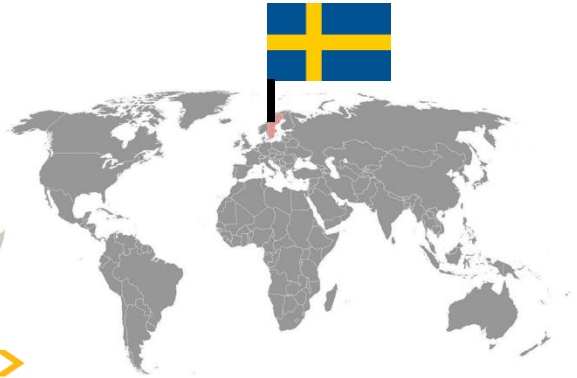


Photo: GKN

GKN AEROSPACE

SIEMENS energy

Photo: Siemens Energy

OVAKO

Sweden's largest electrolyser project inaugurated to produce hydrogen for green steelmaking

Ovako's facility in Hofors will use renewable H2 for industrial heat rather than direct iron reduction, in bid to decarbonise downstream steel processing

2023, Photo: OVAKO

Photo: Alleima

outokumpu

Alleima

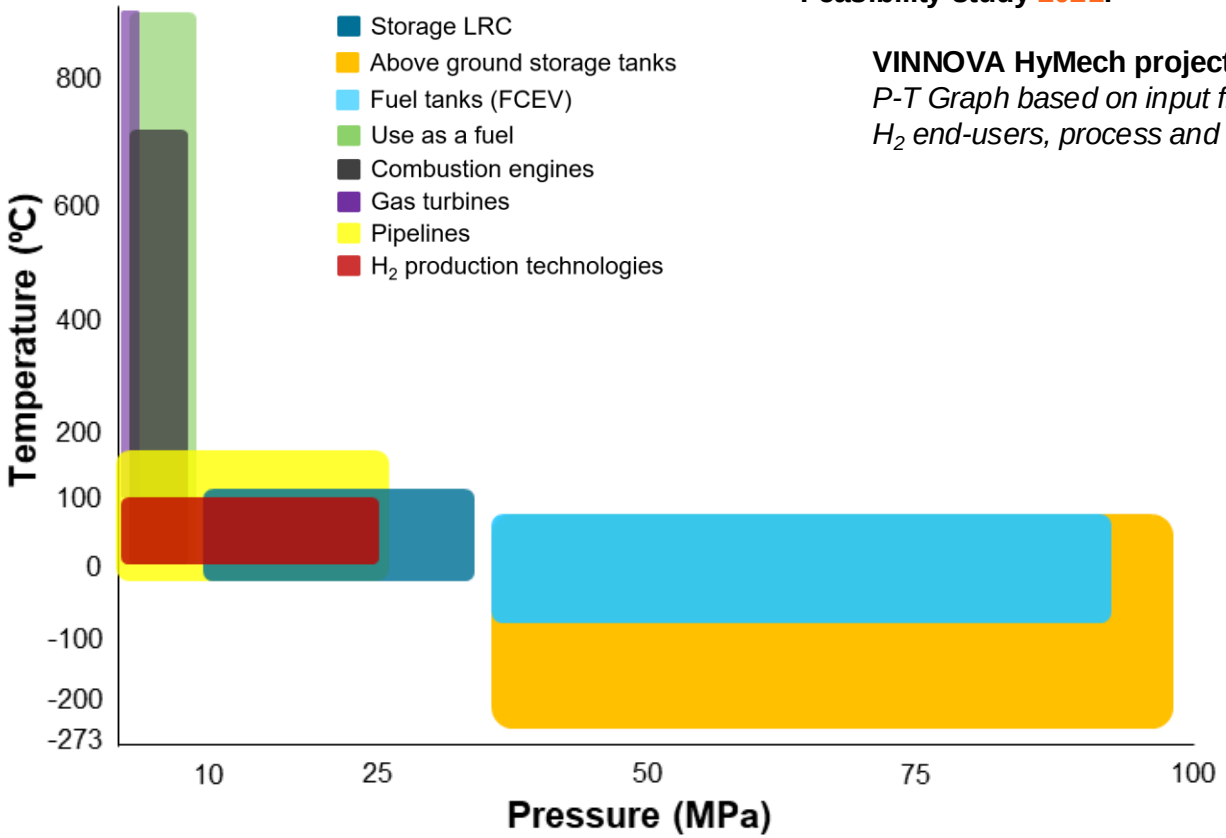
ESAB

NORDION ENERGI

8th October DN.se

Hydrogen Applications and Their Specific Challenges

SWERIM



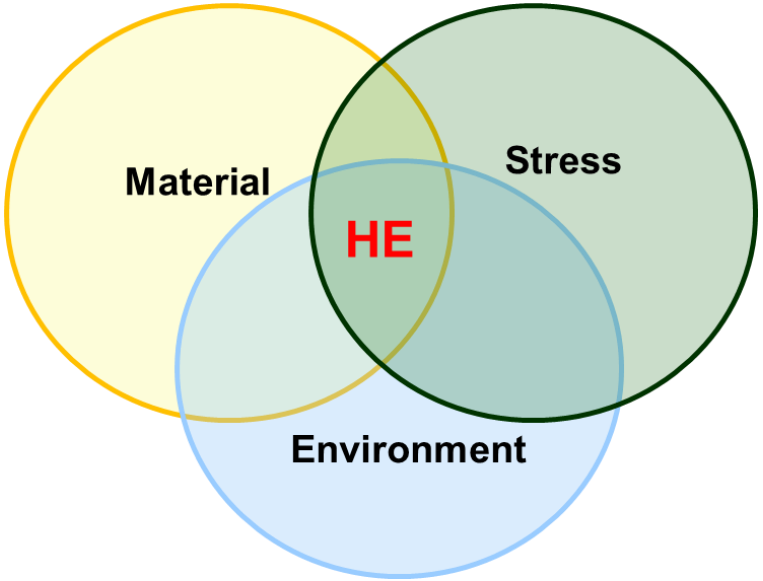
Feasibility study 2021:

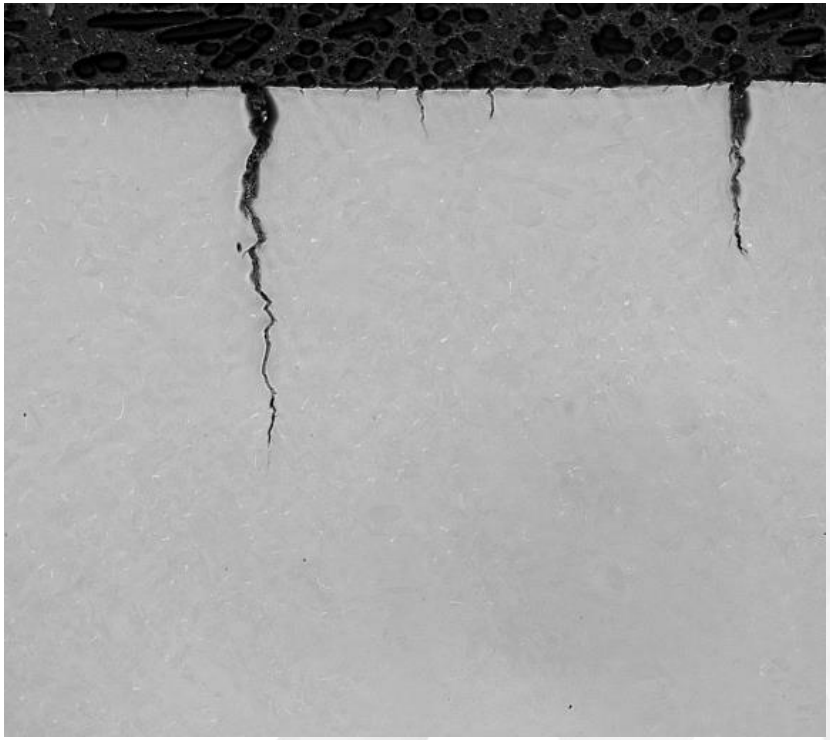
VINNOVA HyMech project

P-T Graph based on input from 15 interviews

H_2 end-users, process and steel industry

Hydrogen embrittlement (**HE**) can potentially lead to catastrophic failures in equipment used in hydrogen environment.





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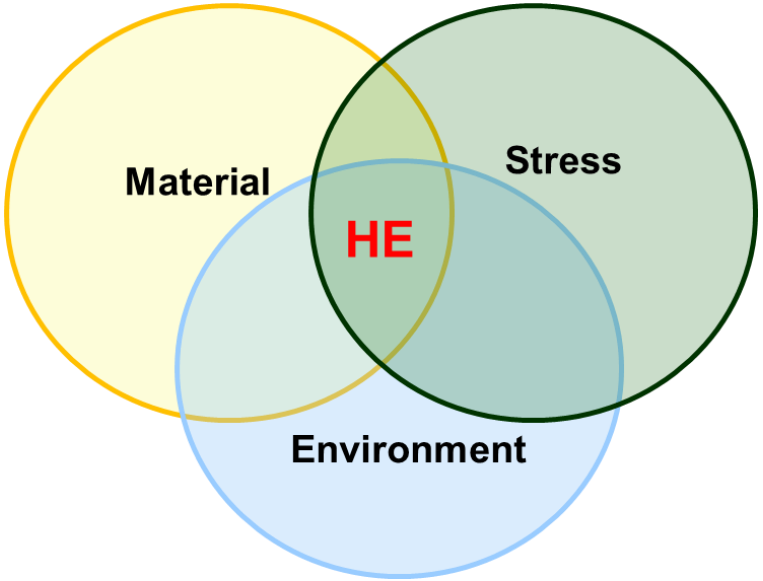
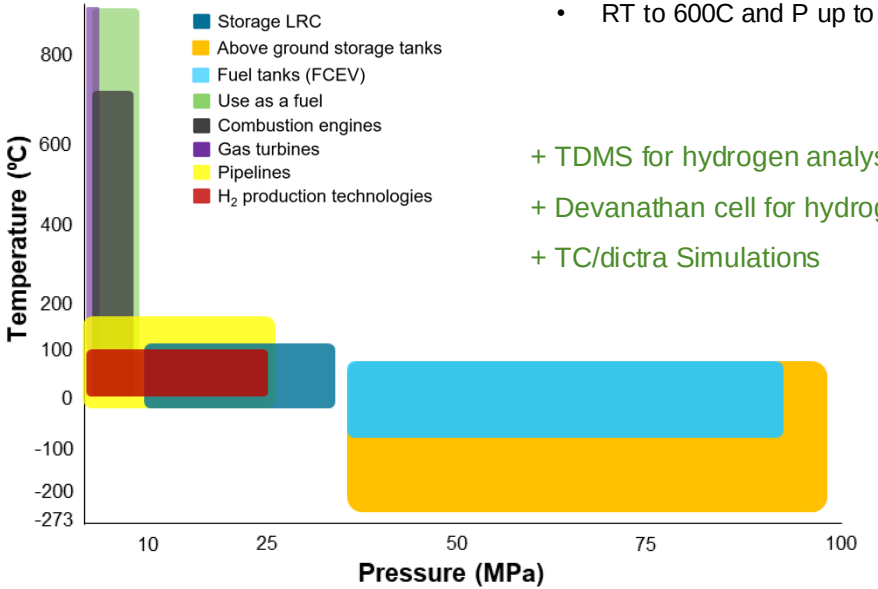


Material testing

Ensure a safe use of materials in H_2

Swerim has unique H2 testing facilities in Sweden

SWERIM



Static autoclaves

- Thermal gas charging
- H uptake at different conditions
- Effect of trapping sites, surface treatments
- RT to 600C and P up to 300 bars

+ TDMS for hydrogen analysis

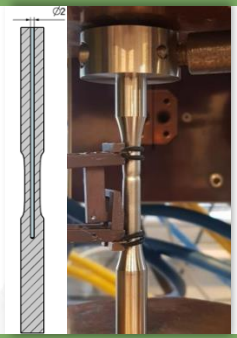
+ Devanathan cell for hydrogen permeation

+ TC/dictra Simulations

Hollow specimen

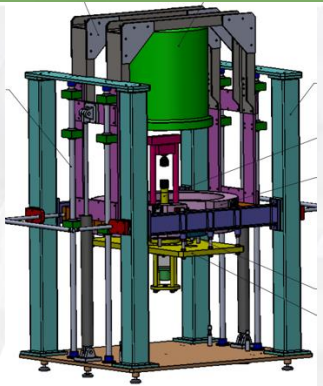
- ISO 7039:2024
- SSRT; fatigue
- -150C up to 1000C
- P up to 1000 bars
- Allows FN measurements
- Innersurface: Ra-value max 0.2 µm

International Organization for Standardization



Large dynamic autoclave

- P up to 1000 bars
- Temperature -80C to 80C
- Allows fracture mechanics testing (CT, K IC, da/dN)
- HCF; LCF, SSRT
- Testing of welds:yes



STORAGE and TRANSPORT

POWER GENERATION
and
HEATING TECHNOLOGIES

TRANSPORTATION

VINNOVA

METALLISKA MATERIAL

HYMECH II

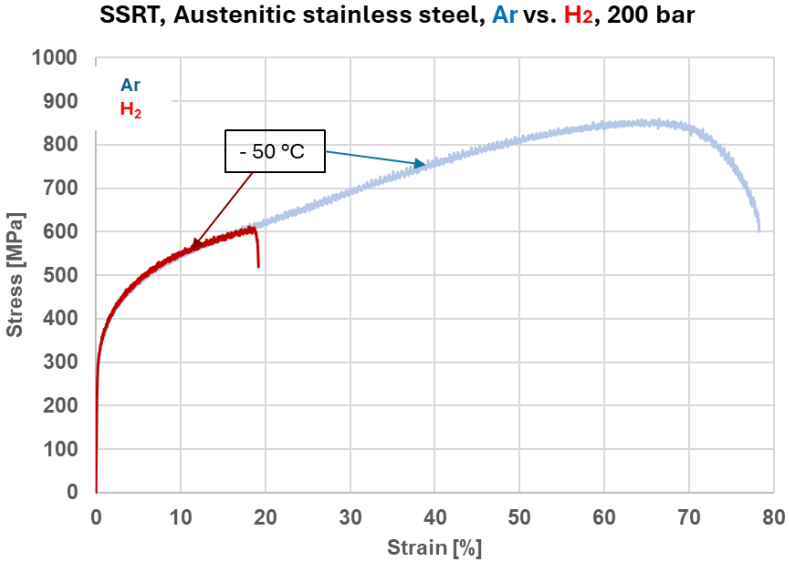
Materials performance in H_2 applications

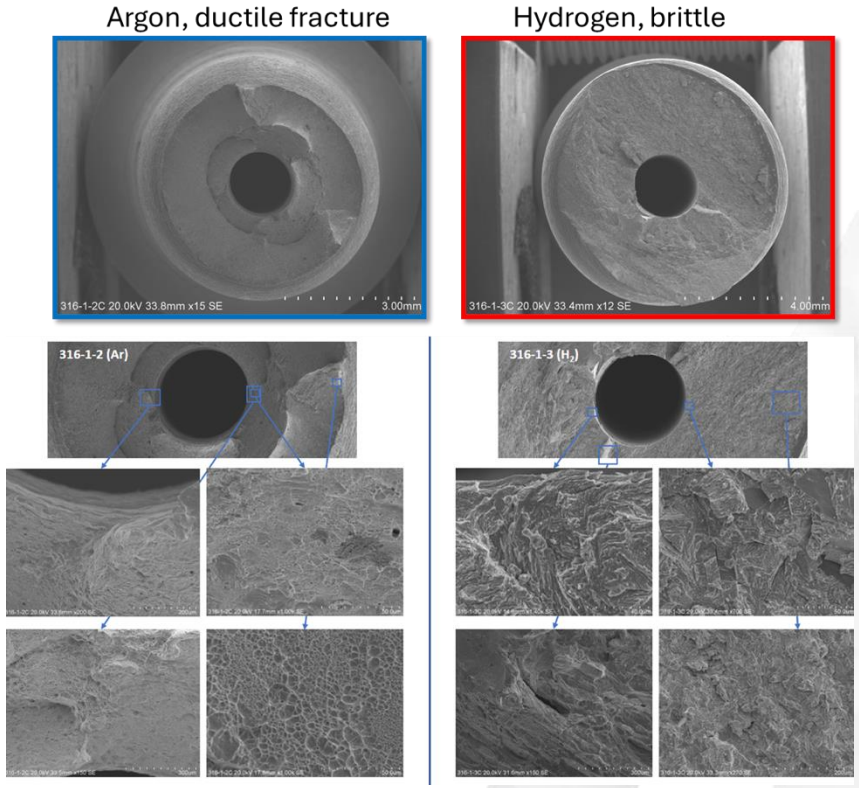
2022-2025

12 partners

EFFECT OF HYDROGEN GAS ON TENSILE PROPERTIES OF AUSTENITIC STAINLESS STEELS AT SUBZERO, ROOM AND ELEVATED TEMPERATURES

H2 Science, Trondheim, June 2024



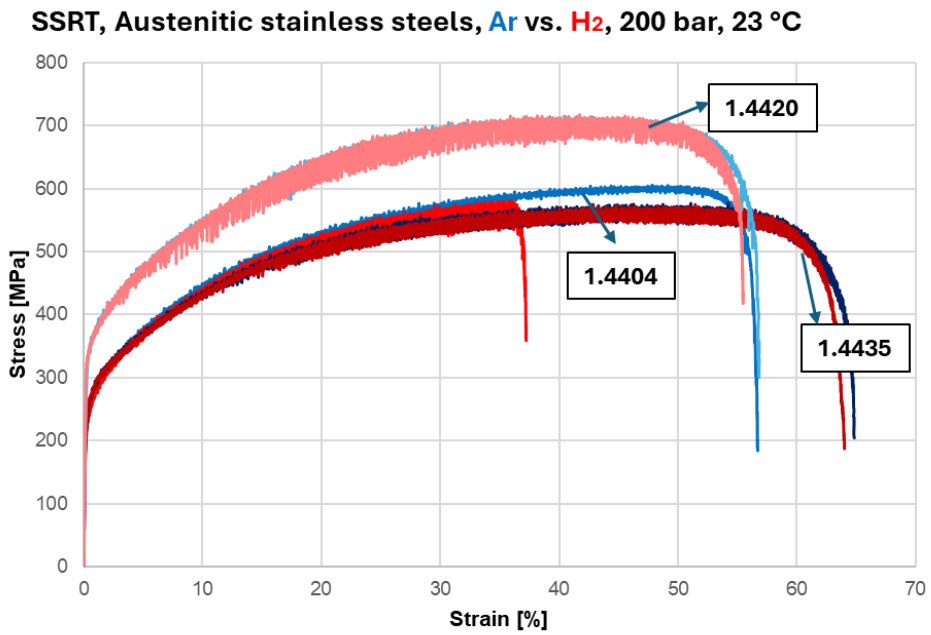


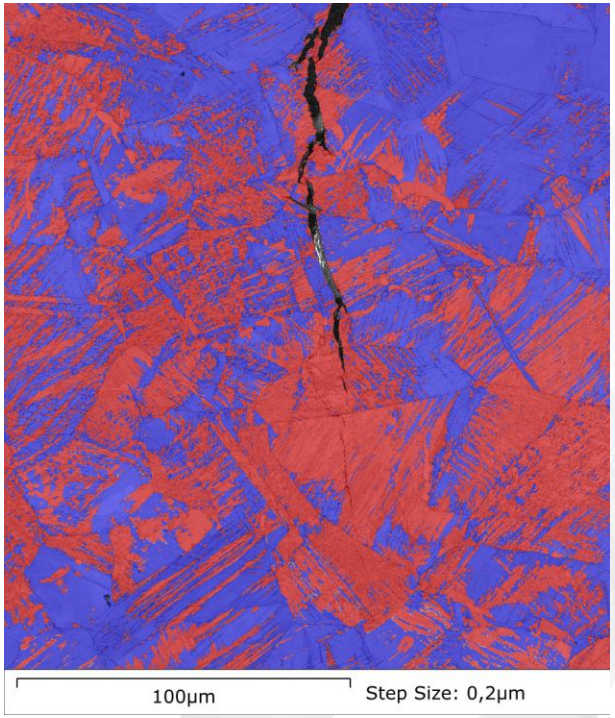
EFFECT OF HYDROGEN GAS ON TENSILE PROPERTIES OF AUSTENITIC STAINLESS STEELS AT SUBZERO, ROOM AND ELEVATED TEMPERATURES

SWERIM

EN 1.4404 vs EN 1.4435 vs EN 1.4420

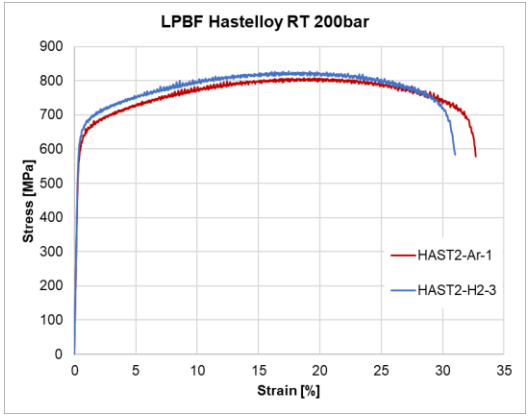
Important to know which grade of stainless steel!

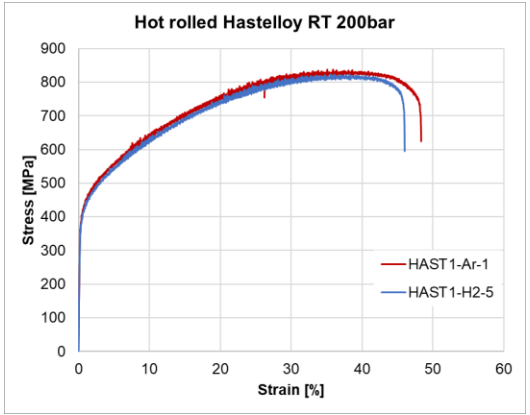




EFFECT OF HIGH-PRESSURE H2 AT ROOM AND HIGH TEMPERATURE ON THE MECHANICAL PERFORMANCE OF CONVENTIONAL AND ADDITIVELY MANUFACTURED Ni-BASE ALLOYS

European Conference on Fracture, August 2024





SGT-800 gas turbine from Siemens Energy

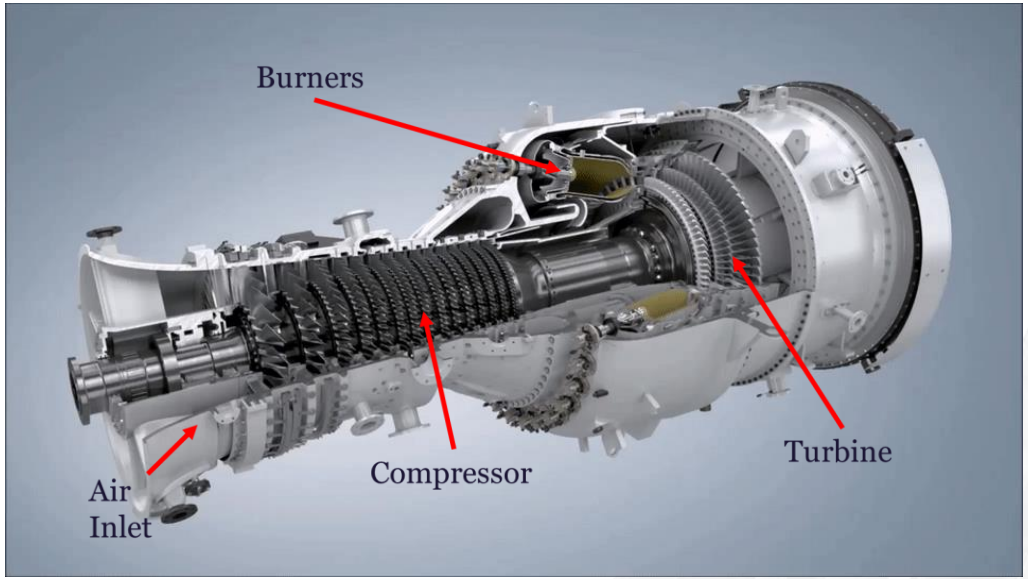


Photo: Siemens Energy

SURFHY
Surface treatments for improved HE resistance

NEW

HYSTRENGTH
Improved material utilization for more sustainable H2 applications

NEW

FINAST PhD project
Carbon steels for H_2 storage and transport

NeXT Center
Neutron and X-ray science for industrial technology Transitions

Microstructure and damage evolution in hydrogen environment

COMING SOON

+ 1 PhD proposal submitted

+ HORIZON/RFCS

STORAGE and TRANSPORT

POWER GENERATION and HEATING TECHNOLOGIES

H_2

TRANSPORTATION

HydrAM PhD project

Hydrogen embrittlement of advanced AM components

OXELHY
Oxide formation in hydrogen combustion heating

HYMECH II
Materials performance in H_2 applications

Challenges and Collaboration Needs

- Need for **safe and reliable material** performance in hydrogen applications
- **Knowledge gaps** on material behaviour in H2
- **Evaluation methods** close to service conditions:
  - Hollow Specimen Method / Autoclave method / Thermal gaseous charging
  - Need for Round Robin tests
- **Time constraints:** hydrogen embrittlment is a time-dependent process
- **New standards are neeeded**


SWERIM